

## Appendix 11.1

### Sunflower Visibility Analysis Performed by KDHE

# **Sunflower Expansion – Alternative Visibility Analysis Using the CAMx Modeling System**

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## **Introduction**

On December 15, 2006 the KDHE received comments from the U.S. Department of the Interior, Fish and Wildlife Service (FWS) concerning the potential visibility impact on the Wichita Mountains Wilderness Class I area from a proposed expansion of the Sunflower Holcomb plant. To address these visibility concerns, the Department and permit applicant representatives worked with the FWS and EPA in establishing a protocol to evaluate the impacts of this expansion on visibility in the Wichita Mountains. This protocol followed ENVIRONMENTal Protection Agency (EPA) and federal land manager (FLM) guidance in choosing CALPUFF as the tool to do this analysis. Unfortunately for this application, CALPUFF is being exercised beyond the normally recommended maximum source receptor distance of 300 km. Knowing that this potential problem could cause an overestimation of the visibility impacts, the KDHE did an additional alternative analysis using the Comprehensive Air Quality Model with Extensions (CAMx) model, which does not have this distance limitation.

## **CAMx overview and datasets used**

CAMx version 4.42, available freely from ENVIRON Corporation [www.camx.com](http://www.camx.com), was used in this modeling analysis. CAMx is a photochemical grid model an Eulerian photochemical dispersion model that allows for an integrated “one-atmosphere” assessment of gaseous and particulate air pollution (ozone, PM<sub>2.5</sub>, PM<sub>10</sub>, air toxics, mercury) over many scales, ranging from sub-urban to continental (ENVIRON 2006a). CAMx simulates the emission, dispersion, chemical reaction, and removal of pollutants in the troposphere by solving the pollutant continuity equation for each chemical species modeled on a system of nested three-dimensional grids.

This version of CAMx includes the implementation of the particulate source apportionment technology (PSAT) within the full-science plume in grid (PiG). This version of CAMx uses a full-chemistry PiG module for near-source plume chemistry and dynamics and a three-dimensional grid model for plume chemistry, transport, and

dispersion at further downwind distances and contains all of the scientific advantages of both CALPUFF and a photochemical grid model.

Because CAMx requires a very data and resource intensive meteorological and emissions inventory dataset, the KDHE relied on the work being done by the Central Air Planning Association (CENRAP) for the Regional Haze Rule. The Department obtained the 2002 MM5 meteorological data and 2002 Base F emissions inventory from EPA Region 7. This emissions inventory data was then augmented with projected emissions from Sunflower's proposed expansion along with the new stack parameters from the proposed expansion. The data used were very similar to those being used in the Texas BART determinations. Please see ENVIRON 2006b for addition description of the datasets used.

For the PSAT setup KDHE used the PSAT/OSAT "point source override" feature (ENVIRON 2006b). This was done by having a source region map with one source region for the entire domain and assigning a separate source region value in the point source input file that will override the source region that the point source resides in. In addition, a negative flag was set for Sunflower stack diameters in order for this point source to receive the PiG treatment. An example of the CAMx script used is provided in Appendix B.

### **Emissions Rates and Stack Parameters**

During the development of the CALPUFF modeling protocol KDHE, FWS, and Sunflower representatives discussed appropriate emissions rates to use in the modeling. It was determined that for visibility impacts an expected worst-case normal operating rate should be used. This worst-case normal operating rate excluded startups, shutdowns, malfunctions, and maintenance activities. It was determined that the rates would be 0.09 lbs/MMBtu for SO<sub>2</sub> and 0.05 lbs/MMBtu for NO<sub>x</sub> for each unit. Because these two pollutants dominate the visibility impacts no other pollutants were modeled. CAMx requires emissions to be speciated and expressed in moles/hour (ENVIRON 2006a), therefore, the emissions rates used in CAMx were NO – 5,769 moles/hour, NO<sub>2</sub> – 641 moles/hour, and SO<sub>2</sub> – 12,427 moles/hour (note this represents all three proposed units operating).

Additional information on the source characteristics can be found in the permit application and CALPUFF modeling protocol (Sunflower Electric Power Corporation. 2006).

### **Visibility Impacts - Methodology**

Visibility impacts were calculated at the Wichita Mountains Class I area using the PSAT tool in CAMx to first estimate the pollutant concentrations of Sunflowers proposed expansion. Visibility impacts were then calculated following the procedures based on the Federal Land Managers' Air Quality Related Values Workgroup report (FLAG, 2000). The FLAG (2000) procedures were developed to estimate visibility impacts at Class I

areas from proposed new sources as part of the Prevention of Significant Deterioration (PSD) and New Source Review (NSR) process.

The IMPROVE reconstructed mass extinction equation is used to estimate visibility at Class I areas using IMPROVE monitoring data, and has also been used for evaluating visibility impacts at Class I areas due to new sources using modeling output of a single source or group of sources. The total light extinction due to a source ( $b_{\text{source}}$ ), in units of inverse megameters ( $\text{Mm}^{-1}$ ), is assumed to be the sum of the light extinction due to the source's individual species concentration impacts times an extinction efficiency coefficient:

$$\begin{aligned} b_{\text{source}} &= b_{\text{SO}_4} + b_{\text{NO}_3} + b_{\text{OC}} + b_{\text{EC}} + b_{\text{soil}} + b_{\text{coarse}} \\ b_{\text{SO}_4} &= 3 [(\text{NH}_4)_2\text{SO}_4]f(\text{RH}) \\ b_{\text{NO}_3} &= 3 [\text{NH}_4\text{NO}_3]f(\text{RH}) \\ b_{\text{OC}} &= 4 [\text{OMC}] \\ b_{\text{EC}} &= 10 [\text{EC}] \\ b_{\text{Soil}} &= 1 [\text{Soil}] \\ b_{\text{coarse}} &= 0.6 [\text{Coarse Mass}] \end{aligned}$$

Here  $f(\text{RH})$  are relative humidity adjustment factors. The concentrations in the square brackets are in  $\mu\text{g}/\text{m}^3$  and are based on the PSAT results. For Wichita Mountains the  $f(\text{RH})$  values used are 2.75 2.55 2.35 2.35 2.74 2.51 2.2 2.37 2.67 2.5 2.59 2.78 for January through December, respectively (EPA, 2003).

The following species mappings are used to map the CAMx species to those used in the IMPROVE reconstructed mass extinction equation given above (ENVIRON, 2006b):

$$\begin{aligned} [(\text{NH}_4)_2\text{SO}_4] &= 1.375 \times \text{PSO}_4 \\ [\text{NH}_4\text{NO}_3] &= 1.290 \times \text{PNO}_3 \\ [\text{OMC}] &= \text{POA} + \text{SOA1} + \text{SOA2} + \text{SOA3} + \text{SOA4} + \text{SOA5} \\ [\text{EC}] &= \text{PEC} \\ [\text{Soil}] &= \text{FPRM} + \text{FCRS} \\ [\text{Coarse Mass}] &= \text{CPRM} + \text{CCRS} \end{aligned}$$

Here  $\text{PSO}_4$  and  $\text{PNO}_3$  are the CAMx particulate sulfate and nitrate species. POA is the CAMx primary particulate organic aerosol species, whereas SOA1-5 are the five secondary organic aerosol species carried in CAMx. Primary elemental carbon is represented by PEC in CAMx. CAMx carries two species that represent the other  $\text{PM}_{2.5}$  components (i.e., fine particles that are not  $\text{SO}_4$ ,  $\text{NO}_3$ , EC, or OC), one for the crustal (FCRS) and the other for the remainder of the primary emitted  $\text{PM}_{2.5}$  species (FPRM). Similarly, CAMx carries two species to represent coarse mass ( $\text{PM}_{2.5-10}$ ), one for crustal (CCRS), and one for other coarse PM (CPRM). For the Sunflower expansion project only  $\text{PSO}_4$  and  $\text{PNO}_3$  were evaluated.

The haze index (HI) for the source is calculated in deciviews (dv) from the source's extinction plus natural background using the following formula:

$$HI_{source} = 10 \ln[(bsource + bnatural)/10]$$

Here, bnatural is the Class I area specific clean natural visibility background, and EPA's default values were used in this analysis. For Wichita Mountains the natural visibility background value used were bnatural = 20.6061 (EPA 2003).

The source's HI was compared against natural conditions to assess the significance of the source's visibility impact. EPA guidance lists natural conditions (bnatural) by Class I area in terms of  $Mm^{-1}$  (ENVIRON, 2006) and assumes clean conditions with no man-made or weather interference. The visibility significance metric for evaluating visibility impact is the change in deciview (del-dv) from the source's and natural conditions haze indices:

$$\begin{aligned} del-dv &= HI_{source} - HI_{natural} = 10 \ln[(bsource + bnatural)/10] - 10 \\ &\ln[bnatural/10] = 10\ln[(bsource + bnatural)/bnatural] \end{aligned}$$

Using CAMx PSAT, Sunflowers proposed expansion was modeled as a source group and the sulfate and nitrate species impacts were determined. Using the above methodology the species were reconstructed for visibility and the del-dv was calculated. A threshold of 0.5 del-dv maximum will be used to assess potential contribution to visibility impairment. This is the same threshold established in the Regional Haze Rule. This del-dv threshold is also being considered by the FLMs as the replacement to the current Method 2 analysis in CALPUFF.

## **Visibility Impacts – Results**

The visibility impacts from Sunflower's proposed expansion were calculated at the Wichita Mountains Class I area and only included the impacts of sulfate and nitrate formation resulting from the sources proposed expansion. Again, the sulfate and nitrate impacts are expected to represent the great majority of the visibility impairment from this source.

Using the methodology described above, the visibility impacts due to sulfate and nitrate on a daily basis (sorted by descending del-dv) were:

| Class I Area | Julian Date | bSO <sub>4</sub> | bNO <sub>3</sub> | Del-dv |
|--------------|-------------|------------------|------------------|--------|
| WIMO1        | 342         | 6.86E-01         | 3.06E-01         | 0.47   |
| WIMO1        | 340         | 5.54E-01         | 1.97E-01         | 0.36   |
| WIMO1        | 38          | 4.07E-01         | 2.76E-01         | 0.33   |
| WIMO1        | 4           | 3.86E-01         | 2.20E-01         | 0.29   |
| WIMO1        | 277         | 5.24E-01         | 4.02E-02         | 0.27   |
| WIMO1        | 360         | 0.175223         | 3.16E-01         | 0.24   |
| WIMO1        | 39          | 2.58E-01         | 2.28E-01         | 0.23   |
| WIMO1        | 343         | 3.30E-01         | 1.23E-01         | 0.22   |
| WIMO1        | 317         | 2.21E-01         | 2.09E-01         | 0.21   |
| WIMO1        | 111         | 0.426719         | 2.35E-03         | 0.21   |

|       |     |           |           |      |
|-------|-----|-----------|-----------|------|
| WIMO1 | 299 | 3.16E-01  | 9.70E-02  | 0.20 |
| WIMO1 | 341 | 3.29E-01  | 8.13E-02  | 0.20 |
| WIMO1 | 112 | 3.88E-01  | 1.29E-02  | 0.19 |
| WIMO1 | 359 | 0.108471  | 0.247125  | 0.17 |
| WIMO1 | 3   | 2.31E-01  | 1.11E-01  | 0.16 |
| WIMO1 | 361 | 0.182219  | 1.50E-01  | 0.16 |
| WIMO1 | 347 | 1.43E-01  | 1.73E-01  | 0.15 |
| WIMO1 | 308 | 2.04E-01  | 8.92E-02  | 0.14 |
| WIMO1 | 325 | 6.88E-02  | 2.15E-01  | 0.14 |
| WIMO1 | 346 | 2.06E-01  | 7.01E-02  | 0.13 |
| WIMO1 | 309 | 1.71E-01  | 7.07E-02  | 0.12 |
| WIMO1 | 321 | 8.84E-02  | 1.26E-01  | 0.10 |
| WIMO1 | 20  | 0.0598496 | 1.25E-01  | 0.09 |
| WIMO1 | 300 | 1.54E-01  | 2.81E-02  | 0.09 |
| WIMO1 | 324 | 5.50E-02  | 1.24E-01  | 0.09 |
| WIMO1 | 345 | 1.43E-01  | 3.53E-02  | 0.09 |
| WIMO1 | 5   | 0.0870633 | 6.99E-02  | 0.08 |
| WIMO1 | 51  | 1.25E-01  | 3.19E-02  | 0.08 |
| WIMO1 | 114 | 1.57E-01  | 1.28E-06  | 0.08 |
| WIMO1 | 258 | 1.49E-01  | 5.95E-03  | 0.07 |
| WIMO1 | 353 | 3.57E-02  | 1.16E-01  | 0.07 |
| WIMO1 | 279 | 1.48E-01  | 1.28E-03  | 0.07 |
| WIMO1 | 351 | 0.038806  | 1.01E-01  | 0.07 |
| WIMO1 | 344 | 1.05E-01  | 3.18E-02  | 0.07 |
| WIMO1 | 278 | 1.14E-01  | 1.78E-02  | 0.06 |
| WIMO1 | 316 | 8.74E-02  | 4.39E-02  | 0.06 |
| WIMO1 | 12  | 0.0340993 | 9.64E-02  | 0.06 |
| WIMO1 | 302 | 1.11E-01  | 1.73E-02  | 0.06 |
| WIMO1 | 320 | 5.18E-02  | 7.37E-02  | 0.06 |
| WIMO1 | 52  | 0.0682877 | 0.0536748 | 0.06 |
| WIMO1 | 13  | 4.13E-02  | 7.87E-02  | 0.06 |
| WIMO1 | 26  | 5.13E-02  | 6.58E-02  | 0.06 |
| WIMO1 | 19  | 3.24E-02  | 8.31E-02  | 0.06 |
| WIMO1 | 6   | 0.0227102 | 9.04E-02  | 0.05 |
| WIMO1 | 348 | 2.94E-02  | 7.91E-02  | 0.05 |
| WIMO1 | 35  | 3.23E-02  | 7.14E-02  | 0.05 |
| WIMO1 | 326 | 3.40E-02  | 6.55E-02  | 0.05 |
| WIMO1 | 356 | 0.025068  | 7.44E-02  | 0.05 |
| WIMO1 | 333 | 5.02E-02  | 4.87E-02  | 0.05 |
| WIMO1 | 332 | 3.27E-02  | 6.60E-02  | 0.05 |
| WIMO1 | 263 | 8.10E-02  | 1.39E-02  | 0.05 |
| WIMO1 | 14  | 2.04E-02  | 7.36E-02  | 0.05 |
| WIMO1 | 25  | 0.0228009 | 6.99E-02  | 0.04 |
| WIMO1 | 7   | 2.26E-02  | 6.85E-02  | 0.04 |
| WIMO1 | 33  | 0.0245823 | 0.0618755 | 0.04 |
| WIMO1 | 47  | 0.0297575 | 5.55E-02  | 0.04 |
| WIMO1 | 1   | 4.55E-02  | 3.92E-02  | 0.04 |
| WIMO1 | 307 | 6.57E-02  | 1.85E-02  | 0.04 |
| WIMO1 | 2   | 3.68E-02  | 4.55E-02  | 0.04 |
| WIMO1 | 327 | 4.06E-02  | 4.14E-02  | 0.04 |

|       |     |           |             |      |
|-------|-----|-----------|-------------|------|
| WIMO1 | 354 | 1.88E-02  | 6.07E-02    | 0.04 |
| WIMO1 | 11  | 0.0147696 | 6.38E-02    | 0.04 |
| WIMO1 | 63  | 0.022538  | 5.42E-02    | 0.04 |
| WIMO1 | 40  | 0.0594941 | 1.67E-02    | 0.04 |
| WIMO1 | 80  | 0.0622436 | 0.0132052   | 0.04 |
| WIMO1 | 264 | 7.10E-02  | 4.11E-03    | 0.04 |
| WIMO1 | 48  | 0.0399502 | 3.41E-02    | 0.04 |
| WIMO1 | 318 | 6.74E-02  | 5.08E-03    | 0.04 |
| WIMO1 | 34  | 2.54E-02  | 4.50E-02    | 0.03 |
| WIMO1 | 68  | 0.0511927 | 0.019053    | 0.03 |
| WIMO1 | 15  | 0.0209406 | 4.78E-02    | 0.03 |
| WIMO1 | 31  | 0.024684  | 0.043762    | 0.03 |
| WIMO1 | 271 | 6.65E-02  | 1.42E-03    | 0.03 |
| WIMO1 | 303 | 5.43E-02  | 1.28E-02    | 0.03 |
| WIMO1 | 56  | 0.0536982 | 1.17E-02    | 0.03 |
| WIMO1 | 270 | 6.30E-02  | 1.06E-03    | 0.03 |
| WIMO1 | 58  | 0.0206062 | 4.26E-02    | 0.03 |
| WIMO1 | 337 | 2.79E-02  | 3.52E-02    | 0.03 |
| WIMO1 | 32  | 0.0182816 | 4.41E-02    | 0.03 |
| WIMO1 | 334 | 2.88E-02  | 3.28E-02    | 0.03 |
| WIMO1 | 322 | 5.10E-02  | 1.05E-02    | 0.03 |
| WIMO1 | 79  | 0.0533059 | 7.91E-03    | 0.03 |
| WIMO1 | 82  | 0.0506305 | 1.03E-02    | 0.03 |
| WIMO1 | 8   | 2.01E-02  | 4.07E-02    | 0.03 |
| WIMO1 | 301 | 5.21E-02  | 8.59E-03    | 0.03 |
| WIMO1 | 257 | 6.00E-02  | 4.14E-04    | 0.03 |
| WIMO1 | 87  | 0.0591416 | 3.33E-04    | 0.03 |
| WIMO1 | 315 | 3.11E-02  | 2.80E-02    | 0.03 |
| WIMO1 | 310 | 3.27E-02  | 2.35E-02    | 0.03 |
| WIMO1 | 21  | 0.0175148 | 3.86E-02    | 0.03 |
| WIMO1 | 314 | 2.93E-02  | 2.56E-02    | 0.03 |
| WIMO1 | 285 | 5.02E-02  | 3.82E-03    | 0.03 |
| WIMO1 | 71  | 0.0448433 | 8.70E-03    | 0.03 |
| WIMO1 | 88  | 0.0525789 | 0.000398339 | 0.03 |
| WIMO1 | 74  | 0.0419255 | 1.08E-02    | 0.03 |
| WIMO1 | 319 | 3.67E-02  | 1.36E-02    | 0.02 |
| WIMO1 | 123 | 4.68E-02  | 5.50E-04    | 0.02 |
| WIMO1 | 83  | 0.046307  | 4.39E-04    | 0.02 |
| WIMO1 | 50  | 4.56E-02  | 6.07E-04    | 0.02 |
| WIMO1 | 37  | 0.0321769 | 1.35E-02    | 0.02 |
| WIMO1 | 27  | 3.14E-02  | 1.42E-02    | 0.02 |
| WIMO1 | 84  | 3.44E-02  | 9.00E-03    | 0.02 |
| WIMO1 | 72  | 3.83E-02  | 4.48E-03    | 0.02 |
| WIMO1 | 59  | 2.28E-02  | 1.98E-02    | 0.02 |
| WIMO1 | 43  | 0.0167564 | 2.47E-02    | 0.02 |
| WIMO1 | 336 | 3.65E-02  | 4.99E-03    | 0.02 |
| WIMO1 | 41  | 0.024677  | 1.62E-02    | 0.02 |
| WIMO1 | 73  | 0.040452  | 5.51E-05    | 0.02 |
| WIMO1 | 328 | 3.09E-02  | 9.24E-03    | 0.02 |
| WIMO1 | 62  | 9.85E-03  | 2.98E-02    | 0.02 |

|       |     |            |             |      |
|-------|-----|------------|-------------|------|
| WIMO1 | 350 | 1.80E-02   | 2.15E-02    | 0.02 |
| WIMO1 | 280 | 3.77E-02   | 1.40E-03    | 0.02 |
| WIMO1 | 122 | 0.0385415  | 2.15E-04    | 0.02 |
| WIMO1 | 311 | 3.11E-02   | 7.32E-03    | 0.02 |
| WIMO1 | 124 | 0.0355916  | 1.97E-04    | 0.02 |
| WIMO1 | 54  | 0.0206799  | 1.46E-02    | 0.02 |
| WIMO1 | 49  | 0.0288634  | 5.57E-03    | 0.02 |
| WIMO1 | 30  | 0.0164938  | 1.79E-02    | 0.02 |
| WIMO1 | 42  | 1.11E-02   | 2.32E-02    | 0.02 |
| WIMO1 | 265 | 3.24E-02   | 1.77E-03    | 0.02 |
| WIMO1 | 323 | 1.50E-02   | 1.87E-02    | 0.02 |
| WIMO1 | 312 | 3.15E-02   | 3.68E-04    | 0.02 |
| WIMO1 | 24  | 0.0121605  | 0.0191778   | 0.02 |
| WIMO1 | 86  | 0.0272782  | 4.04E-03    | 0.02 |
| WIMO1 | 168 | 3.10E-02   | 1.79E-04    | 0.02 |
| WIMO1 | 330 | 1.24E-02   | 1.85E-02    | 0.01 |
| WIMO1 | 355 | 1.15E-02   | 1.86E-02    | 0.01 |
| WIMO1 | 119 | 0.0285772  | 0.00129779  | 0.01 |
| WIMO1 | 306 | 2.40E-02   | 5.89E-03    | 0.01 |
| WIMO1 | 364 | 1.67E-02   | 1.26E-02    | 0.01 |
| WIMO1 | 167 | 2.87E-02   | 2.96E-05    | 0.01 |
| WIMO1 | 254 | 2.81E-02   | 4.32E-05    | 0.01 |
| WIMO1 | 60  | 0.0220048  | 4.42E-03    | 0.01 |
| WIMO1 | 272 | 2.60E-02   | 8.46E-05    | 0.01 |
| WIMO1 | 294 | 2.38E-02   | 1.36E-03    | 0.01 |
| WIMO1 | 295 | 2.41E-02   | 9.69E-04    | 0.01 |
| WIMO1 | 113 | 0.0243216  | 4.66E-05    | 0.01 |
| WIMO1 | 22  | 0.0164938  | 7.30E-03    | 0.01 |
| WIMO1 | 81  | 1.74E-02   | 6.25E-03    | 0.01 |
| WIMO1 | 304 | 1.88E-02   | 4.60E-03    | 0.01 |
| WIMO1 | 66  | 0.0221696  | 9.46E-04    | 0.01 |
| WIMO1 | 16  | 1.47E-02   | 8.10E-03    | 0.01 |
| WIMO1 | 57  | 6.72E-03   | 1.54E-02    | 0.01 |
| WIMO1 | 146 | 0.0215539  | 0.000192141 | 0.01 |
| WIMO1 | 23  | 1.57E-02   | 5.86E-03    | 0.01 |
| WIMO1 | 305 | 1.80E-02   | 3.27E-03    | 0.01 |
| WIMO1 | 267 | 2.04E-02   | 7.18E-04    | 0.01 |
| WIMO1 | 291 | 2.00E-02   | 1.05E-03    | 0.01 |
| WIMO1 | 143 | 0.0209209  | 2.65E-11    | 0.01 |
| WIMO1 | 331 | 8.50E-03   | 1.24E-02    | 0.01 |
| WIMO1 | 142 | 0.0207853  | 1.88E-05    | 0.01 |
| WIMO1 | 115 | 2.01E-02   | 2.24E-04    | 0.01 |
| WIMO1 | 36  | 9.66E-03   | 1.06E-02    | 0.01 |
| WIMO1 | 141 | 1.99E-02   | 3.29E-04    | 0.01 |
| WIMO1 | 46  | 0.0124858  | 7.62E-03    | 0.01 |
| WIMO1 | 100 | 0.0192421  | 4.53E-04    | 0.01 |
| WIMO1 | 65  | 0.019339   | 2.31E-04    | 0.01 |
| WIMO1 | 55  | 0.0187865  | 5.55E-04    | 0.01 |
| WIMO1 | 129 | 0.0190447  | 6.13E-05    | 0.01 |
| WIMO1 | 17  | 0.00802911 | 1.09E-02    | 0.01 |

|       |     |            |             |      |
|-------|-----|------------|-------------|------|
| WIMO1 | 145 | 1.88E-02   | 1.10E-04    | 0.01 |
| WIMO1 | 290 | 1.47E-02   | 4.12E-03    | 0.01 |
| WIMO1 | 262 | 1.85E-02   | 2.13E-04    | 0.01 |
| WIMO1 | 28  | 1.67E-02   | 1.92E-03    | 0.01 |
| WIMO1 | 99  | 1.78E-02   | 6.73E-04    | 0.01 |
| WIMO1 | 125 | 1.71E-02   | 2.61E-05    | 0.01 |
| WIMO1 | 313 | 1.69E-02   | 1.78E-06    | 0.01 |
| WIMO1 | 29  | 0.0123987  | 4.46E-03    | 0.01 |
| WIMO1 | 151 | 1.68E-02   | 1.12E-05    | 0.01 |
| WIMO1 | 118 | 0.016809   | 1.82E-05    | 0.01 |
| WIMO1 | 281 | 1.61E-02   | 6.65E-04    | 0.01 |
| WIMO1 | 53  | 6.79E-03   | 9.65E-03    | 0.01 |
| WIMO1 | 91  | 1.31E-02   | 3.25E-03    | 0.01 |
| WIMO1 | 10  | 9.78E-03   | 6.52E-03    | 0.01 |
| WIMO1 | 273 | 1.62E-02   | 3.54E-05    | 0.01 |
| WIMO1 | 339 | 1.03E-02   | 5.41E-03    | 0.01 |
| WIMO1 | 85  | 0.0126213  | 2.97E-03    | 0.01 |
| WIMO1 | 133 | 0.0153149  | 1.28E-04    | 0.01 |
| WIMO1 | 130 | 0.0154166  | 1.47E-06    | 0.01 |
| WIMO1 | 269 | 1.47E-02   | 4.81E-04    | 0.01 |
| WIMO1 | 92  | 1.42E-02   | 0.000951285 | 0.01 |
| WIMO1 | 266 | 1.44E-02   | 6.69E-04    | 0.01 |
| WIMO1 | 296 | 1.39E-02   | 8.57E-04    | 0.01 |
| WIMO1 | 75  | 0.0119524  | 2.33E-03    | 0.01 |
| WIMO1 | 69  | 8.23E-03   | 6.01E-03    | 0.01 |
| WIMO1 | 64  | 0.0113998  | 1.77E-03    | 0.01 |
| WIMO1 | 238 | 1.28E-02   | 9.02E-05    | 0.01 |
| WIMO1 | 268 | 1.26E-02   | 1.36E-04    | 0.01 |
| WIMO1 | 102 | 1.21E-02   | 5.32E-04    | 0.01 |
| WIMO1 | 18  | 6.38E-03   | 5.99E-03    | 0.01 |
| WIMO1 | 169 | 1.21E-02   | 4.71E-11    | 0.01 |
| WIMO1 | 89  | 0.0108085  | 1.02E-03    | 0.01 |
| WIMO1 | 134 | 1.17E-02   | 1.45E-04    | 0.01 |
| WIMO1 | 76  | 0.0104789  | 1.21E-03    | 0.01 |
| WIMO1 | 293 | 9.81E-03   | 1.74E-03    | 0.01 |
| WIMO1 | 144 | 1.15E-02   | 5.14E-06    | 0.01 |
| WIMO1 | 259 | 1.14E-02   | 4.35E-05    | 0.01 |
| WIMO1 | 357 | 0.00366501 | 7.67E-03    | 0.01 |
| WIMO1 | 226 | 1.09E-02   | 2.06E-04    | 0.01 |
| WIMO1 | 237 | 1.10E-02   | 2.61E-05    | 0.01 |
| WIMO1 | 358 | 0.00369368 | 0.00724161  | 0.01 |
| WIMO1 | 150 | 0.0107905  | 5.78E-05    | 0.01 |
| WIMO1 | 260 | 1.03E-02   | 9.56E-05    | 0.01 |
| WIMO1 | 288 | 7.43E-03   | 2.96E-03    | 0.01 |
| WIMO1 | 120 | 0.0101881  | 1.17E-04    | 0.00 |
| WIMO1 | 90  | 8.27E-03   | 1.77E-03    | 0.00 |
| WIMO1 | 96  | 0.00979069 | 1.98E-04    | 0.00 |
| WIMO1 | 136 | 0.00996768 | 2.86E-07    | 0.00 |
| WIMO1 | 77  | 0.00939034 | 0.000493468 | 0.00 |
| WIMO1 | 158 | 9.62E-03   | 1.62E-04    | 0.00 |

|       |     |            |             |      |
|-------|-----|------------|-------------|------|
| WIMO1 | 70  | 0.00943396 | 1.98E-05    | 0.00 |
| WIMO1 | 363 | 8.88E-03   | 0.000545031 | 0.00 |
| WIMO1 | 97  | 9.01E-03   | 2.95E-04    | 0.00 |
| WIMO1 | 274 | 9.10E-03   | 1.09E-06    | 0.00 |
| WIMO1 | 95  | 8.42E-03   | 6.55E-04    | 0.00 |
| WIMO1 | 135 | 9.04E-03   | 1.33E-11    | 0.00 |
| WIMO1 | 140 | 0.00829716 | 3.09E-04    | 0.00 |
| WIMO1 | 255 | 8.34E-03   | 2.37E-04    | 0.00 |
| WIMO1 | 61  | 4.98E-03   | 3.26E-03    | 0.00 |
| WIMO1 | 253 | 8.07E-03   | 1.06E-04    | 0.00 |
| WIMO1 | 352 | 0.00203777 | 5.95E-03    | 0.00 |
| WIMO1 | 110 | 7.51E-03   | 3.98E-04    | 0.00 |
| WIMO1 | 298 | 6.16E-03   | 1.42E-03    | 0.00 |
| WIMO1 | 256 | 7.26E-03   | 3.06E-05    | 0.00 |
| WIMO1 | 283 | 7.05E-03   | 2.00E-04    | 0.00 |
| WIMO1 | 338 | 2.67E-03   | 4.35E-03    | 0.00 |
| WIMO1 | 292 | 6.69E-03   | 2.73E-04    | 0.00 |
| WIMO1 | 204 | 6.88E-03   | 2.92E-05    | 0.00 |
| WIMO1 | 170 | 0.0068107  | 1.50E-06    | 0.00 |
| WIMO1 | 67  | 6.54E-03   | 5.78E-05    | 0.00 |
| WIMO1 | 138 | 0.00641982 | 1.81E-05    | 0.00 |
| WIMO1 | 194 | 0.00632437 | 4.46E-05    | 0.00 |
| WIMO1 | 284 | 5.86E-03   | 2.26E-04    | 0.00 |
| WIMO1 | 286 | 5.04E-03   | 1.04E-03    | 0.00 |
| WIMO1 | 101 | 0.00588023 | 5.34E-05    | 0.00 |
| WIMO1 | 289 | 4.39E-03   | 1.41E-03    | 0.00 |
| WIMO1 | 103 | 5.55E-03   | 2.20E-04    | 0.00 |
| WIMO1 | 137 | 0.00562978 | 9.86E-07    | 0.00 |
| WIMO1 | 329 | 4.04E-03   | 1.38E-03    | 0.00 |
| WIMO1 | 227 | 5.39E-03   | 1.32E-05    | 0.00 |
| WIMO1 | 45  | 3.58E-03   | 1.60E-03    | 0.00 |
| WIMO1 | 239 | 5.08E-03   | 1.95E-06    | 0.00 |
| WIMO1 | 159 | 0.00488904 | 1.04E-05    | 0.00 |
| WIMO1 | 282 | 4.68E-03   | 2.18E-04    | 0.00 |
| WIMO1 | 362 | 2.79E-03   | 0.00207318  | 0.00 |
| WIMO1 | 132 | 0.00424183 | 9.09E-05    | 0.00 |
| WIMO1 | 349 | 2.31E-03   | 1.90E-03    | 0.00 |
| WIMO1 | 157 | 0.00410733 | 4.06E-05    | 0.00 |
| WIMO1 | 93  | 0.00343256 | 5.35E-04    | 0.00 |
| WIMO1 | 147 | 3.84E-03   | 4.79E-06    | 0.00 |
| WIMO1 | 261 | 3.77E-03   | 2.37E-06    | 0.00 |
| WIMO1 | 78  | 3.08E-03   | 4.53E-04    | 0.00 |
| WIMO1 | 139 | 3.35E-03   | 3.42E-06    | 0.00 |
| WIMO1 | 104 | 0.00301669 | 5.69E-05    | 0.00 |
| WIMO1 | 94  | 2.75E-03   | 2.93E-04    | 0.00 |
| WIMO1 | 98  | 0.00299343 | 5.17E-05    | 0.00 |
| WIMO1 | 205 | 0.0030129  | 1.09E-05    | 0.00 |
| WIMO1 | 240 | 2.93E-03   | 1.10E-05    | 0.00 |
| WIMO1 | 171 | 0.0029239  | 7.93E-07    | 0.00 |
| WIMO1 | 44  | 0.00105503 | 1.75E-03    | 0.00 |

|       |     |             |             |      |
|-------|-----|-------------|-------------|------|
| WIMO1 | 152 | 0.00259465  | 1.23E-06    | 0.00 |
| WIMO1 | 220 | 2.56E-03    | 8.90E-06    | 0.00 |
| WIMO1 | 116 | 0.00233135  | 0.000152969 | 0.00 |
| WIMO1 | 252 | 2.40E-03    | 6.37E-06    | 0.00 |
| WIMO1 | 109 | 0.00220533  | 1.10E-04    | 0.00 |
| WIMO1 | 9   | 1.97E-03    | 3.01E-04    | 0.00 |
| WIMO1 | 275 | 2.14E-03    | 1.81E-06    | 0.00 |
| WIMO1 | 166 | 2.07E-03    | 1.18E-11    | 0.00 |
| WIMO1 | 250 | 2.07E-03    | 9.29E-06    | 0.00 |
| WIMO1 | 241 | 2.03E-03    | 1.43E-05    | 0.00 |
| WIMO1 | 335 | 8.07E-04    | 1.16E-03    | 0.00 |
| WIMO1 | 297 | 1.60E-03    | 2.94E-04    | 0.00 |
| WIMO1 | 193 | 1.82E-03    | 6.11E-06    | 0.00 |
| WIMO1 | 165 | 1.77E-03    | 1.49E-05    | 0.00 |
| WIMO1 | 247 | 1.70E-03    | 1.17E-05    | 0.00 |
| WIMO1 | 221 | 1.65E-03    | 5.18E-05    | 0.00 |
| WIMO1 | 105 | 0.00167217  | 6.02E-06    | 0.00 |
| WIMO1 | 149 | 0.0015993   | 4.60E-06    | 0.00 |
| WIMO1 | 222 | 0.00136085  | 1.35E-05    | 0.00 |
| WIMO1 | 225 | 1.36E-03    | 4.25E-12    | 0.00 |
| WIMO1 | 148 | 0.001319    | 7.41E-06    | 0.00 |
| WIMO1 | 218 | 1.26E-03    | 2.35E-07    | 0.00 |
| WIMO1 | 242 | 1.17E-03    | 7.42E-06    | 0.00 |
| WIMO1 | 117 | 1.18E-03    | 1.64E-06    | 0.00 |
| WIMO1 | 219 | 0.0011536   | 1.47E-06    | 0.00 |
| WIMO1 | 131 | 0.00102966  | 6.23E-06    | 0.00 |
| WIMO1 | 243 | 9.34E-04    | 9.12E-06    | 0.00 |
| WIMO1 | 217 | 0.000853467 | 1.18E-05    | 0.00 |
| WIMO1 | 249 | 8.56E-04    | 7.77E-06    | 0.00 |
| WIMO1 | 276 | 8.43E-04    | 8.72E-06    | 0.00 |
| WIMO1 | 248 | 8.40E-04    | 4.85E-06    | 0.00 |
| WIMO1 | 156 | 0.000839482 | 8.57E-07    | 0.00 |
| WIMO1 | 172 | 0.000790509 | 6.36E-07    | 0.00 |
| WIMO1 | 228 | 7.86E-04    | 7.93E-08    | 0.00 |
| WIMO1 | 154 | 0.000749197 | 1.51E-07    | 0.00 |
| WIMO1 | 106 | 6.83E-04    | 9.44E-07    | 0.00 |
| WIMO1 | 287 | 5.68E-04    | 4.60E-05    | 0.00 |
| WIMO1 | 244 | 5.61E-04    | 4.59E-06    | 0.00 |
| WIMO1 | 246 | 5.47E-04    | 4.05E-12    | 0.00 |
| WIMO1 | 155 | 0.000493253 | 2.96E-07    | 0.00 |
| WIMO1 | 153 | 4.50E-04    | 8.50E-08    | 0.00 |
| WIMO1 | 224 | 0.000450294 | 2.17E-12    | 0.00 |
| WIMO1 | 160 | 0.000435479 | 7.54E-07    | 0.00 |
| WIMO1 | 207 | 4.32E-04    | 1.46E-08    | 0.00 |
| WIMO1 | 126 | 4.29E-04    | 1.37E-06    | 0.00 |
| WIMO1 | 197 | 0.000385688 | 8.34E-06    | 0.00 |
| WIMO1 | 192 | 3.69E-04    | 5.18E-07    | 0.00 |
| WIMO1 | 121 | 0.000356368 | 9.53E-08    | 0.00 |
| WIMO1 | 216 | 3.56E-04    | 1.97E-07    | 0.00 |
| WIMO1 | 179 | 0.000342295 | 4.56E-07    | 0.00 |

|       |     |             |          |      |
|-------|-----|-------------|----------|------|
| WIMO1 | 245 | 3.17E-04    | 1.05E-06 | 0.00 |
| WIMO1 | 196 | 0.000282868 | 8.68E-06 | 0.00 |
| WIMO1 | 206 | 0.000274247 | 1.56E-06 | 0.00 |
| WIMO1 | 195 | 0.000254826 | 2.07E-06 | 0.00 |
| WIMO1 | 229 | 2.56E-04    | 8.10E-08 | 0.00 |
| WIMO1 | 174 | 0.000233891 | 8.64E-06 | 0.00 |
| WIMO1 | 175 | 2.14E-04    | 7.55E-06 | 0.00 |
| WIMO1 | 191 | 0.000198289 | 7.81E-07 | 0.00 |
| WIMO1 | 211 | 0.000184313 | 7.54E-06 | 0.00 |
| WIMO1 | 223 | 0.000187117 | 1.47E-06 | 0.00 |
| WIMO1 | 164 | 0.000181398 | 4.45E-07 | 0.00 |
| WIMO1 | 173 | 1.77E-04    | 6.43E-07 | 0.00 |
| WIMO1 | 178 | 0.00016711  | 3.13E-07 | 0.00 |
| WIMO1 | 251 | 1.55E-04    | 1.74E-07 | 0.00 |
| WIMO1 | 208 | 1.53E-04    | 4.28E-09 | 0.00 |
| WIMO1 | 190 | 0.000149375 | 5.07E-07 | 0.00 |
| WIMO1 | 163 | 0.000133667 | 5.03E-08 | 0.00 |
| WIMO1 | 214 | 1.17E-04    | 4.68E-08 | 0.00 |
| WIMO1 | 176 | 1.11E-04    | 1.52E-07 | 0.00 |
| WIMO1 | 107 | 9.31E-05    | 2.28E-07 | 0.00 |
| WIMO1 | 177 | 9.37E-05    | 3.84E-07 | 0.00 |
| WIMO1 | 108 | 8.59E-05    | 6.97E-07 | 0.00 |
| WIMO1 | 189 | 8.19E-05    | 2.96E-06 | 0.00 |
| WIMO1 | 203 | 8.49E-05    | 1.12E-09 | 0.00 |
| WIMO1 | 230 | 8.28E-05    | 6.27E-07 | 0.00 |
| WIMO1 | 215 | 7.68E-05    | 1.11E-07 | 0.00 |
| WIMO1 | 127 | 7.22E-05    | 2.04E-07 | 0.00 |
| WIMO1 | 180 | 6.48E-05    | 2.88E-07 | 0.00 |
| WIMO1 | 188 | 5.98E-05    | 1.47E-06 | 0.00 |
| WIMO1 | 236 | 4.82E-05    | 2.17E-13 | 0.00 |
| WIMO1 | 231 | 4.68E-05    | 1.53E-07 | 0.00 |
| WIMO1 | 234 | 3.93E-05    | 1.37E-13 | 0.00 |
| WIMO1 | 235 | 3.88E-05    | 2.14E-09 | 0.00 |
| WIMO1 | 162 | 3.65E-05    | 7.11E-09 | 0.00 |
| WIMO1 | 209 | 3.73E-05    | 8.54E-10 | 0.00 |
| WIMO1 | 232 | 3.51E-05    | 3.90E-09 | 0.00 |
| WIMO1 | 210 | 3.08E-05    | 5.57E-08 | 0.00 |
| WIMO1 | 233 | 3.22E-05    | 6.59E-11 | 0.00 |
| WIMO1 | 200 | 2.42E-05    | 9.72E-09 | 0.00 |
| WIMO1 | 202 | 2.37E-05    | 1.56E-09 | 0.00 |
| WIMO1 | 213 | 2.50E-05    | 3.05E-10 | 0.00 |
| WIMO1 | 199 | 1.89E-05    | 3.45E-09 | 0.00 |
| WIMO1 | 161 | 1.38E-05    | 3.86E-10 | 0.00 |
| WIMO1 | 201 | 1.33E-05    | 1.27E-08 | 0.00 |
| WIMO1 | 187 | 7.74E-06    | 1.04E-07 | 0.00 |
| WIMO1 | 198 | 7.95E-06    | 4.86E-09 | 0.00 |
| WIMO1 | 212 | 7.42E-06    | 2.66E-08 | 0.00 |
| WIMO1 | 128 | 4.27E-06    | 3.55E-07 | 0.00 |
| WIMO1 | 183 | 5.40E-06    | 4.62E-08 | 0.00 |
| WIMO1 | 185 | 5.07E-06    | 1.29E-07 | 0.00 |

|       |     |          |          |      |
|-------|-----|----------|----------|------|
| WIMO1 | 186 | 6.05E-06 | 7.24E-08 | 0.00 |
| WIMO1 | 182 | 2.56E-06 | 4.84E-09 | 0.00 |
| WIMO1 | 184 | 2.23E-06 | 9.13E-08 | 0.00 |
| WIMO1 | 181 | 1.12E-06 | 6.10E-09 | 0.00 |
| WIMO1 | 365 | 0        | 0        | 0.00 |

These results indicate that sulfate impacts are about twice that of nitrate for the majority of the days that have higher del-dv impacts. These higher modeled days generally occurred in the winter months when the weather patterns take the plume toward the Wichita Mountains. On the day with maximum modeled del-dv (0.47), Julian day 342 (December 8, 2002), the sulfate impact was 2.24 times that of the nitrate. This is to be expected as the emissions rate for sulfate is higher than nitrate for Sunflowers proposed expansion, and during this time of year sulfate is the dominant pollutant impacting visibility in the Wichita Mountains Class I area, as Figure 1 shows.

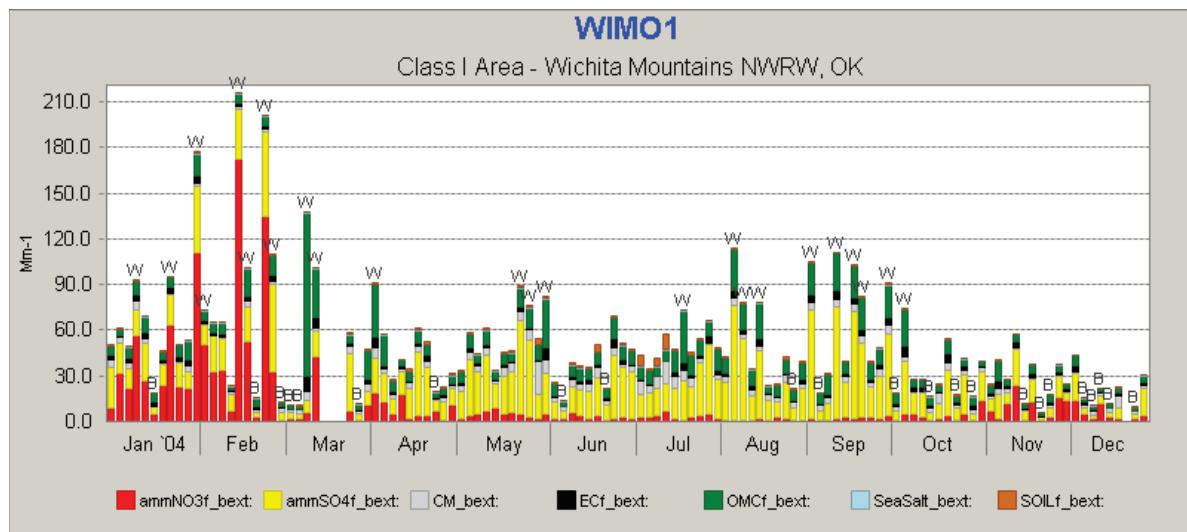


Figure 1. Monthly monitored visibility species impacts in 2004 for Wichita Mountains.

Appendix A contains graphics of the sulfate plume location for the five highest del-dv days.

## Conclusion

The proposed Sunflower Holcomb expansion has been evaluated for visibility impacts using the alternative CAMx model utilizing PSAT and PiG. The results indicate that for the year modeled the maximum visibility attributed to the proposed expansion would be 0.47 del-dv. This maximum modeled del-dv occurred on December 8, 2002. Based on this level of maximum visibility impacts under worst case normal operating conditions, the modeling indicates the proposed Sunflower expansion does not adversely impact visibility in the Wichita Mountains Class I area in Oklahoma. KDHE believes this analysis is more representative than the CALPUFF analysis because of the large source receptor distance from Sunflower to surrounding Class I areas (~400 km).

## References

EPA. 2003. Guidance for Estimating Natural Visibility Conditions under the Regional Haze Rule. EPA-454/B-03-005. U.S. ENVIRONMENTAL Protection Agency, Research Triangle Park, NC.

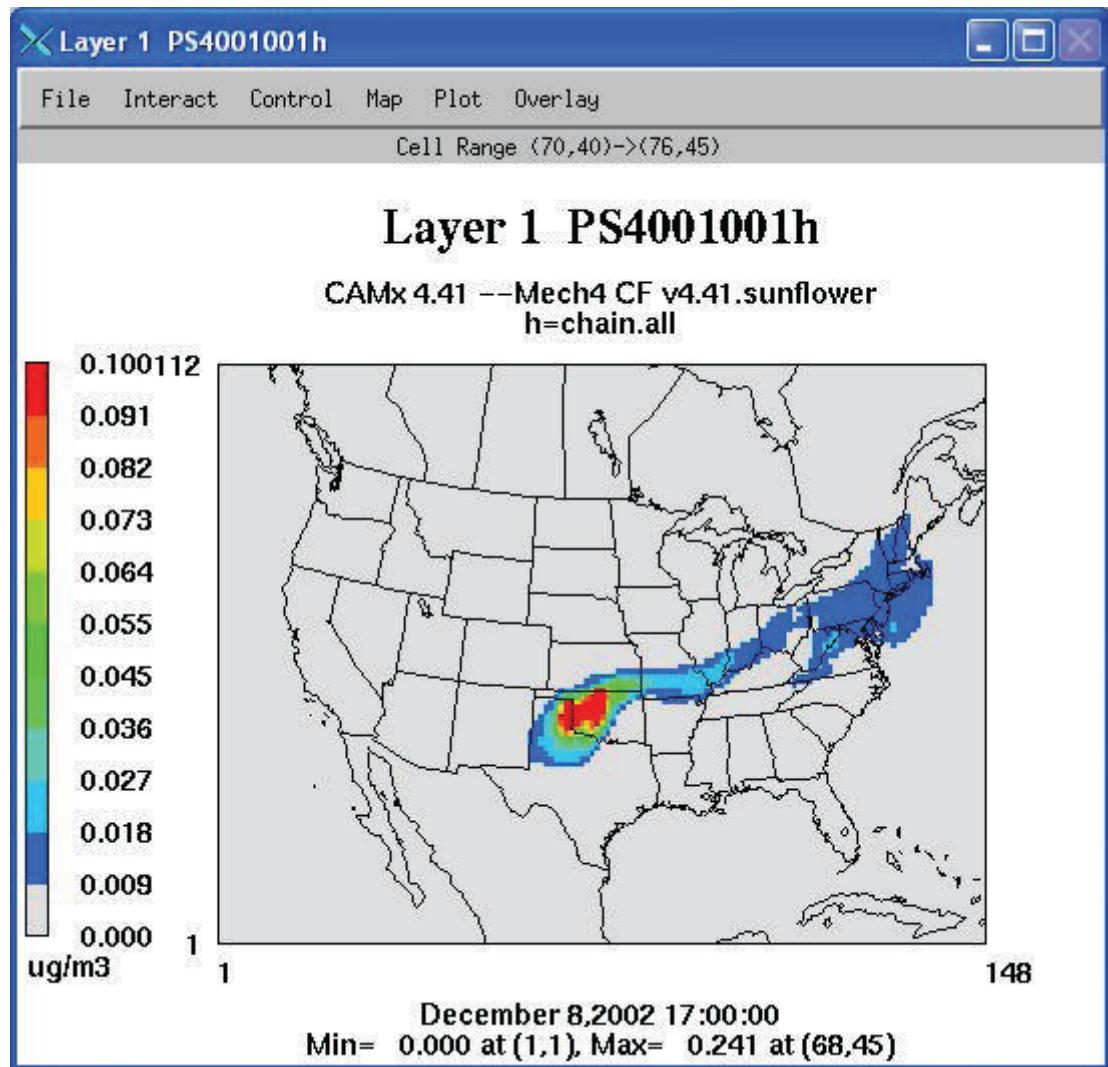
ENVIRON. 2006a. "User's Guide – Comprehensive Air-quality Model with extensions, Version 4.40." ENVIRON International Corporation, Novato, California. (Available at <http://www.camx.com>). September 2006

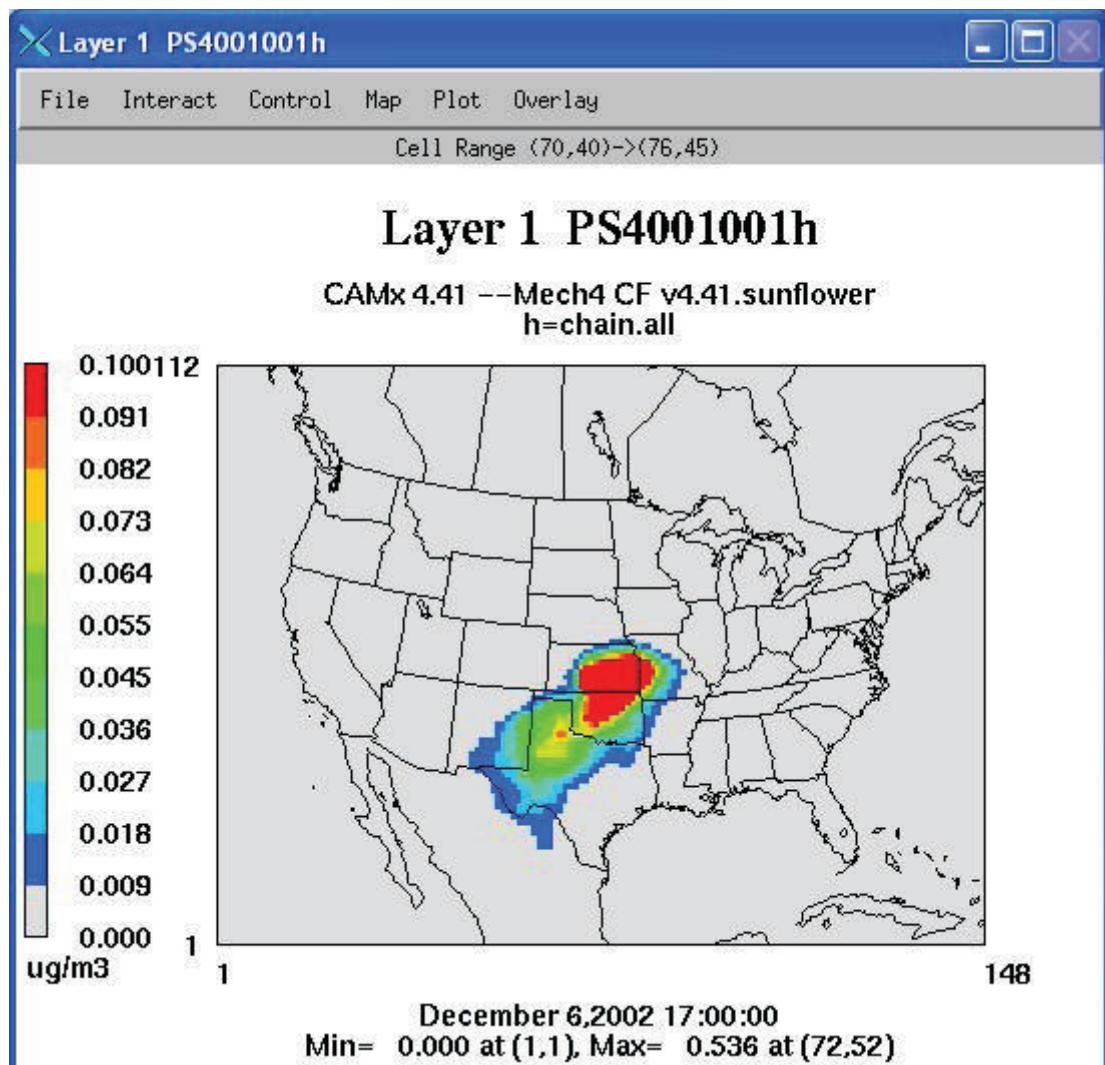
ENVIRON. 2006b. Guidance for the Application of the CAMx Hybrid Photochemical Grid Model to Assess Visibility Impacts of Texas BART Sources at Class I Areas. Prepared for Texas Commission of ENVIRONMENTAL Quality, Austin Texas. Prepared by ENVIRON International Corporation, Novato, CA. September 27.

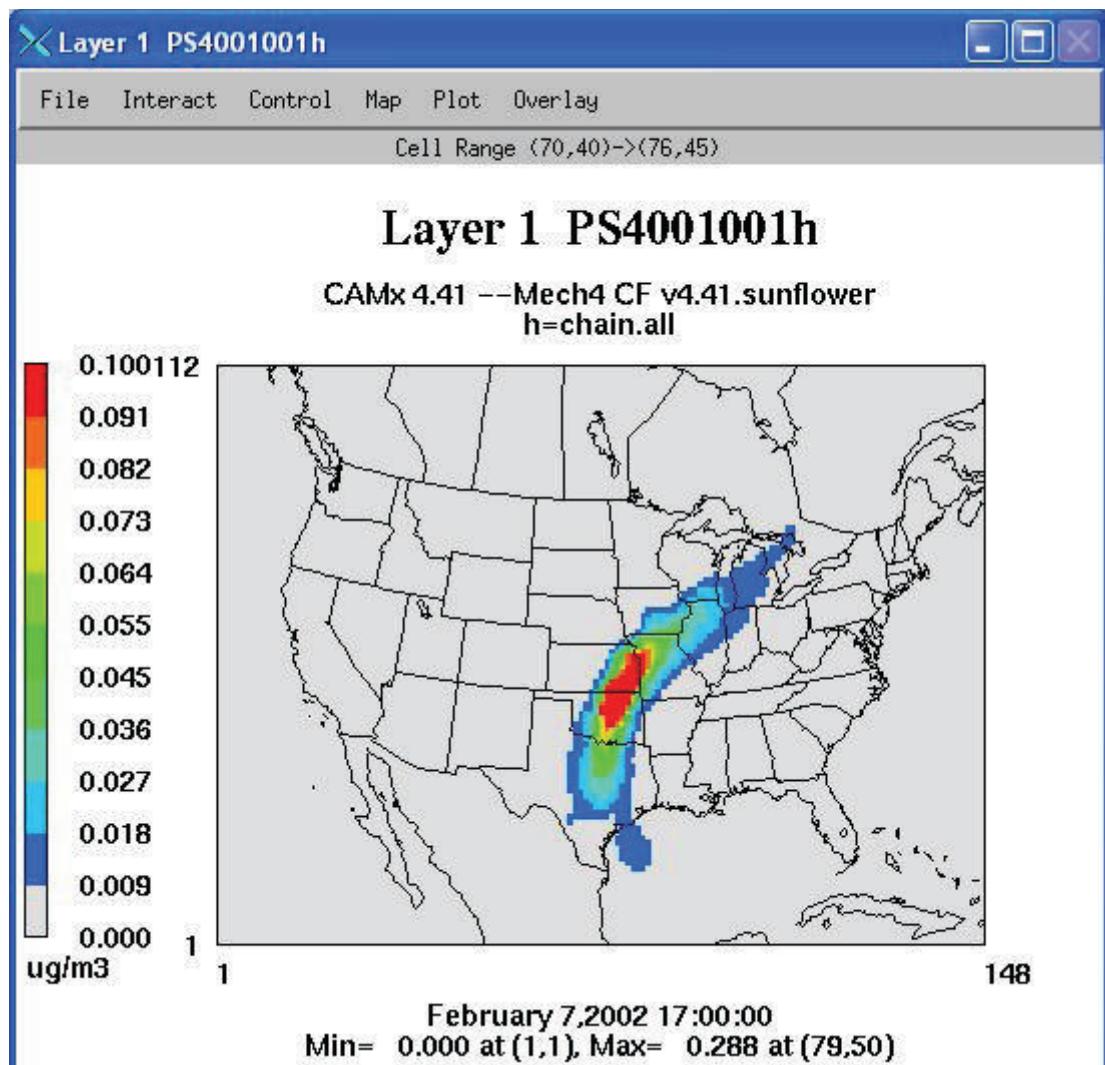
FLAG. 2000. "Federal Land Managers' Air Quality Related Values Workgroup (FLAG)": Phase I Report. USDI – National Park Service, Air Resources Division, Denver, CO.

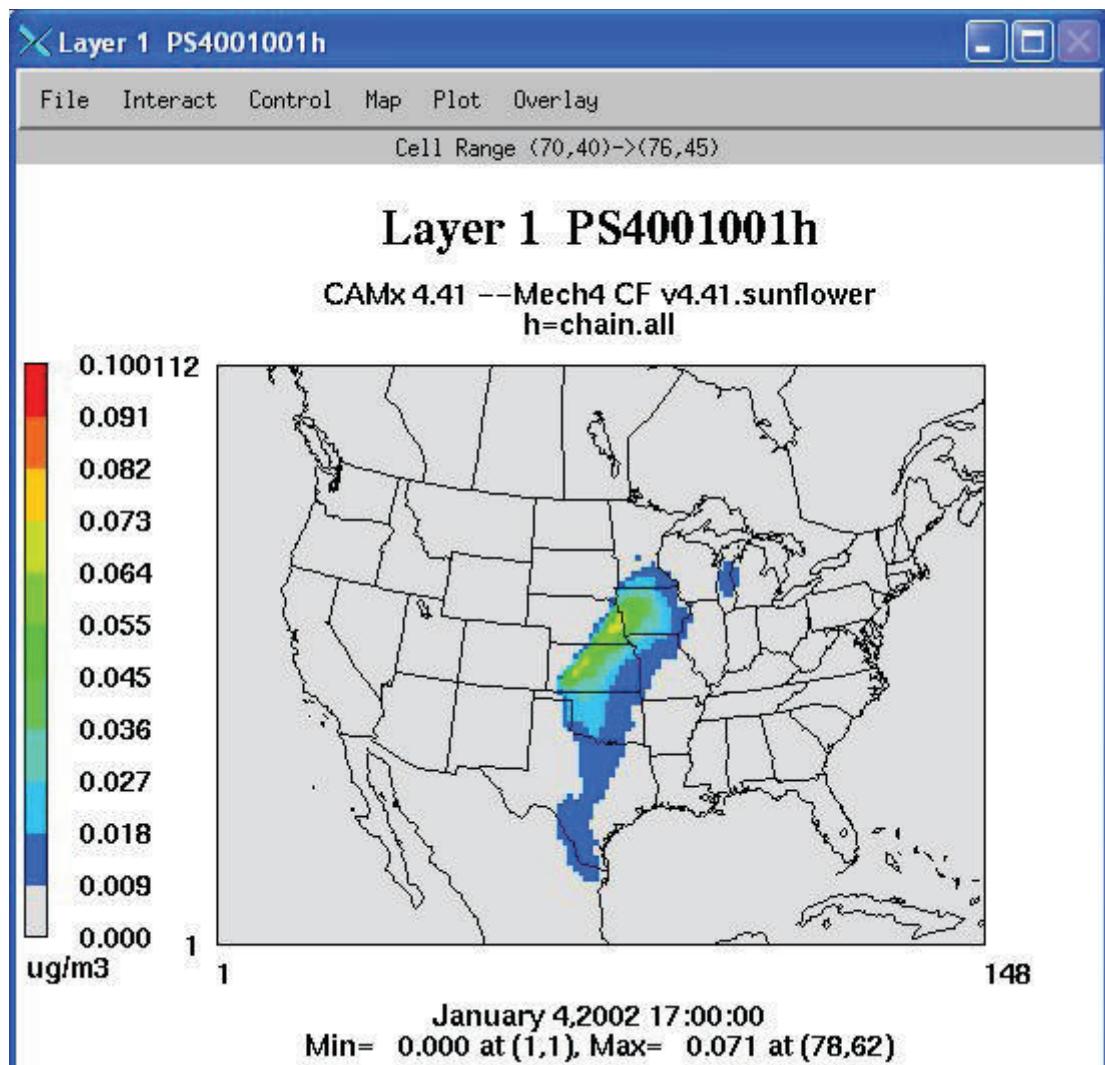
Sunflower Electric Power Corporation. 2006. Holcomb Expansion Project Visibility Impact on Class I areas and PM2.5 Impact in Northeast Kansas. Prepared by HDR Engineering, Inc. November 2006.

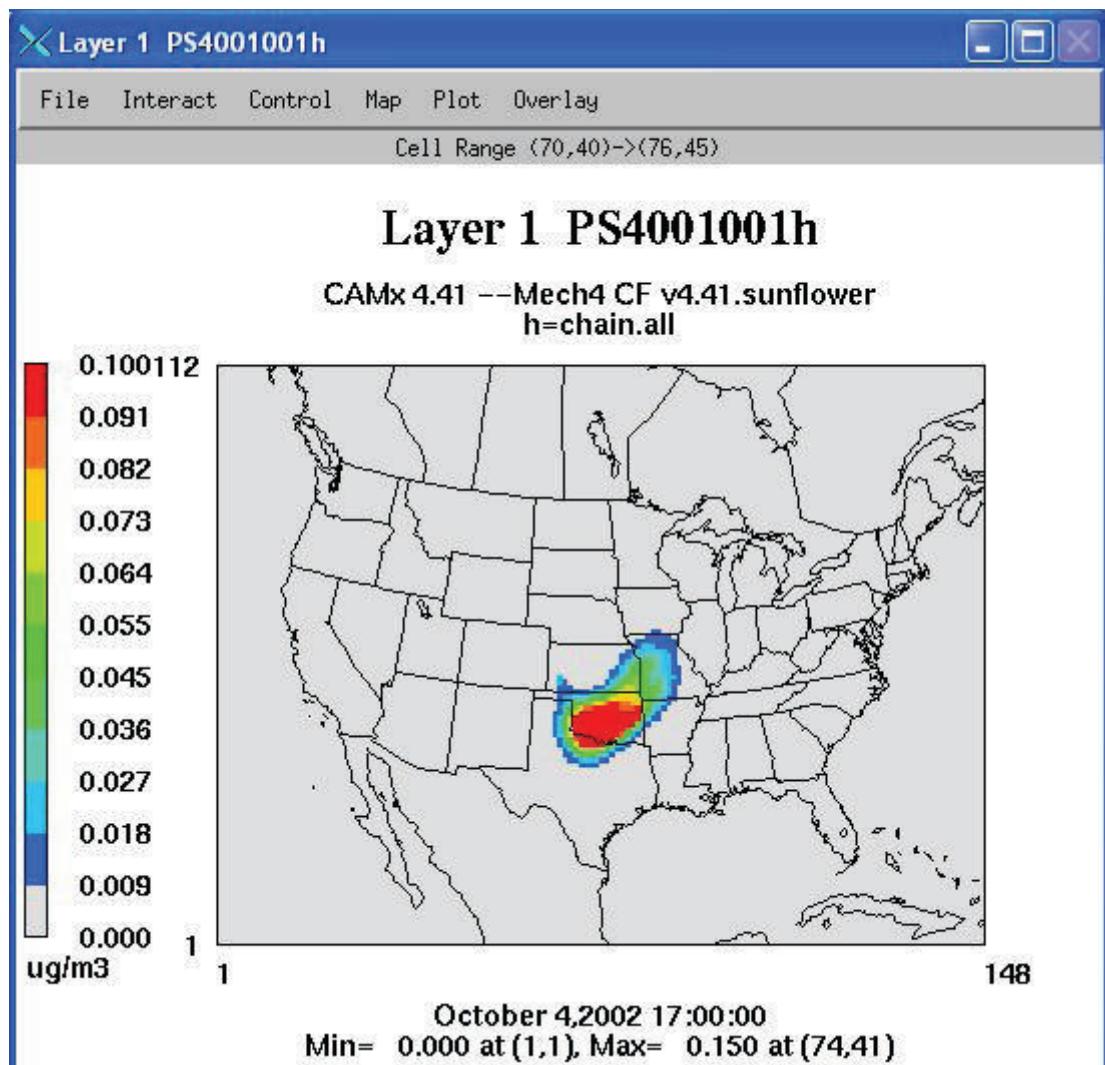
## Appendix A Sulfate Plume (ug/m<sup>3</sup>) Location During High del-dv Impacts.











## **Appendix B - CAMx Script Used for Sunflower PSAT Analysis Using the SO<sub>4</sub> and NO<sub>3</sub> PSAT Tracers**

```
#!/bin/csh
#
# CAMx 4.31
#
setenv NCPUS 4
setenv MPSTKZ 128M
limit stacksize unlimited
set EXEC    = "/modeling/cenrap_psat/src.fixed/CAMx.sunflower.pg_linuxomp"
#
#
set run = revised_psat.Q1
set STARTDATE = 2001356
set ENDDATE  = 2002365
set JDATE = 2001356
#
set RUN   = "v4.42.sunflower"
set CHEM  = "/mnt/usb2/modeling/inputs/inputs"
set LUSE   = "/mnt/usb2/modeling/inputs/landuse"
set AHOMAP = "/mnt/usb2/modeling/inputs/ahomap"
set PHOT   = "/mnt/usb2/modeling/inputs/tuv"
set ICBC   = "/mnt/usb2/modeling/inputs/icbctc"
set MET    = "/mnt/usb2/modeling/inputs/met_new/36"
set EMIS   = "/modeling/cenrap_psat/merged"
set EMIS2  = "/mnt/usb2/modeling/cenrap02f/area_uam"
set OUTPUT = "/modeling/cenrap_psat/outputs/$run"
#
mkdir -p $OUTPUT $run
#
# --- set the dates and times ----
#
while ( $JDATE <= $ENDDATE )

set RESTART = "true"
if( $JDATE == $STARTDATE ) set RESTART = "false"

@ YESTERDAY = $JDATE - 1
if( $YESTERDAY == 2002000 ) set YESTERDAY = 2001365
set YYYY = `./j2g $JDATE | awk '{print $1}'`
set Y2 = `echo $YYYY | awk '{printf("%2.2d",$1-2000)}`"
set MM = `./j2g $JDATE | awk '{print $2}'`
set DD = `./j2g $JDATE | awk '{print $3}'`
```

```
echo '---- Copying Files ----'
```

```
cp -v $EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin  
$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt  
.revised.bin.copy >> & $OUTPUT/CAMx.$RUN.$JDATE.stdout  
cp -v $EMIS2/camx.ar.bart.36km.$JDATE.bin  
$EMIS2/camx.ar.bart.36km.$JDATE.bin.copy >> &  
$OUTPUT/CAMx.$RUN.$JDATE.stdout  
ut
```

```
#  
# --- Create the input file (always called CAMx.in)  
#  
cat << ieof > CAMx.in
```

```
&CAMx_Control
```

```
Run_Message = 'CAMx 4.41 --Mech4 CF $RUN',
```

```
!--- Model clock control ---
```

```
Time_Zone = 0, ! (0=UTC,5=EST,6=CST,7=MST,8=PST)  
Restart = ${RESTART},  
Start_Date_Hour = ${YYYY},${MM},${DD},0000, !(YYYY,MM,DD,HHHH)  
End_Date_Hour = ${YYYY},${MM},${DD},2400, !(YYYY,MM,DD,HHHH)
```

```
Maximum_Timestep = 15., ! minutes  
Met_Input_Frequency = 60., ! minutes  
Ems_Input_Frequency = 60., ! minutes  
Output_Frequency = 60., ! minutes
```

```
!--- Map projection parameters ---
```

```
Map_Projection = 'LAMBERT', !(LAMBERT,POLAR,UTM,LATLON)  
UTM_Zone = 0,  
POLAR_Longitude_Pole = 0., ! deg (west<0,south<0)  
POLAR_Latitude_Pole = 0., ! deg (west<0,south<0)  
LAMBERT_Central_Meridian = -97., ! deg (west<0,south<0)  
LAMBERT_Center_Longitude = -97., ! deg (west<0,south<0)  
LAMBERT_Center_Latitude = 40., ! deg (west<0,south<0)  
LAMBERT_True_Latitude1 = 45., ! deg (west<0,south<0)  
LAMBERT_True_Latitude2 = 33., ! deg (west<0,south<0)
```

```
!--- Parameters for the master (first) grid ---
```

```
Number_of_Grids = 1,  
Master-Origin_XCoord = -2736., ! km or deg, SW corner of cell(1,1)  
Master-Origin_YCoord = -2088., ! km or deg, SW corner of cell (1,1)  
Master_Cell_XSize = 36., ! km or deg  
Master_Cell_YSize = 36., ! km or deg  
Master_Grid_Columns = 148,  
Master_Grid_Rows = 112,  
Number_of_Layers(1) = 19,
```

!--- Parameters for the second grid ---

```
Nest_Meshing_Factor(2) = 3, ! Relative to master grid  
Nest_Beg_I_Index(2) = 31, ! Relative to master grid  
Nest_End_I_Index(2) = 69, ! Relative to master grid  
Nest_Beg_J_Index(2) = 29, ! Relative to master grid  
Nest_End_J_Index(2) = 72, ! Relative to master grid  
Number_of_Layers(2) = 14,
```

!--- Model options ---

```
Diagnostic_Error_Check = .false., ! True = will stop after 1st timestep  
Advection_Solver = 'PPM', ! (PPM,BOTT)  
Chemistry_Solver = 'CMC', ! (CMC,IEH)  
PiG_Submodel = 'GREASD', ! (None,GREASD,IRON)  
Probing_Tool = 'PSAT', ! (None,OSAT,GOAT,APCA,DDM,PA,RTRAC)  
Chemistry = .true.,  
Dry_Deposition = .true.,  
Wet_Deposition = .true.,  
Staggered_Winds = .true.,  
Gridded_Emissions = .true.,  
Point_Emissions = .true.,  
Ignore_Emission_Dates = .true.,
```

!--- Output specifications ---

```
Root_Output_Name = '$OUTPUT/camx.$RUN.$JDATE',  
Average_Output_3D = .false.,  
HDF_Format_Output = .false.,  
Number_of_Output_Species = 35,  
Output_Species_Names(1) = 'NO',  
Output_Species_Names(2) = 'NO2',  
Output_Species_Names(3) = 'O3',  
Output_Species_Names(4) = 'PAN',  
Output_Species_Names(5) = 'NXYO',  
Output_Species_Names(6) = 'CO',  
Output_Species_Names(7) = 'HONO',
```

```

Output_Species_Names(8) = 'HNO3',
Output_Species_Names(9) = 'NTR',
Output_Species_Names(10) = 'SO2',
Output_Species_Names(11) = 'SULF',
Output_Species_Names(12) = 'NH3',
Output_Species_Names(13) = 'HCL',
Output_Species_Names(14) = 'CG1',
Output_Species_Names(15) = 'CG2',
Output_Species_Names(16) = 'CG3',
Output_Species_Names(17) = 'CG4',
Output_Species_Names(18) = 'CG5',
Output_Species_Names(19) = 'PNO3',
Output_Species_Names(20) = 'PSO4',
Output_Species_Names(21) = 'PNH4',
Output_Species_Names(22) = 'POA',
Output_Species_Names(23) = 'SOA1',
Output_Species_Names(24) = 'SOA2',
Output_Species_Names(25) = 'SOA3',
Output_Species_Names(26) = 'SOA4',
Output_Species_Names(27) = 'SOA5',
Output_Species_Names(28) = 'PEC',
Output_Species_Names(29) = 'FPRM',
Output_Species_Names(30) = 'FCRS',
Output_Species_Names(31) = 'CPRM',
Output_Species_Names(32) = 'CCRS',
Output_Species_Names(33) = 'NA',
Output_Species_Names(34) = 'PCL',
Output_Species_Names(35) = 'PH2O',

```

!--- Input files ---

```

Chemistry_Parameters = '$CHEM/CAMx4.4.chemparam.4_CF',
Photolyis_Rates     = '$PHOT/tuv.wrap36km.${YYYY}${MM}.20051013.txt',
Initial_Conditions  = '$ICBC/ic.wrap36km.CAMx',
Boundary_Conditions = '$ICBC/bc.wrap36km.CAMx.$JDATE',
Top_Concentrations = '$ICBC/topc.wrap36km.CAMx',
Albedo_Haze_Ozone   = '$AHOMAP/ahomap.${YYYY}${MM}.20051013.txt',
Point_Sources       =
'$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin',
Master_Grid_Restart = '$OUTPUT/camx.$RUN.$YESTERDAY.inst',
Nested_Grid_Restart = '',
PiG_Restart         = '$OUTPUT/camx.$RUN.$YESTERDAY.pig',

Emiss_Grid(1) = '$EMIS2/camx.ar.bart.36km.$JDATE.bin',
Landuse_Grid(1) = '$LUSE/CAMx.wrap36km.luse.bin',
ZP_Grid(1)      = '$MET/camx.zp.${Y2}${MM}${DD}.36k.bin',

```

```
Wind_Grid(1) = '$MET/camx.uv.${Y2}${MM}${DD}.36k.bin',
Temp_Grid(1) = '$MET/camx.tp.${Y2}${MM}${DD}.36k.bin',
Vapor_Grid(1) = '$MET/camx.qa.${Y2}${MM}${DD}.36k.bin',
Cloud_Grid(1) = '$MET/camx.cr.${Y2}${MM}${DD}.36k.bin',
Kv_Grid(1) = '$MET/camx.kv.OB70.${Y2}${MM}${DD}.36k.bin',
Emiss_Grid(2) = '',
Landuse_Grid(2) = '',
ZP_Grid(2) = '',
Wind_Grid(2) = '',
Temp_Grid(2) = '',
Vapor_Grid(2) = '',
Cloud_Grid(2) = '',
Kv_Grid(2) = ''
```

&

!-----

#### &SA\_Control

```
SA_File_Root      = '$OUTPUT/camx.$RUN.$run.$JDATE',
SA_Summary_Output = .true.,
SA_Master_Sfc_Output = .true.,
SA_Stratify_Boundary = .false.,
SA_Number_of_Source_Regions = 2,
SA_Number_of_Source_Groups = 1,
Use_Leftover_Group = .false.,
Number_of_Timing_Releases = 0,
SA_Receptor_Definitions =
'/mnt/usb2/modeling/camx(sa/receptor.nebraska.classI.txt',
SA_Source_Area_Map(1) =
'/mnt/usb2/modeling/cenrap_psat/camx/srcmap/srcmap.dat',
SA_Master_Restart = '$OUTPUT/camx.$RUN.$run.$YESTERDAY.sa.inst',
SA_Nested_Restart = '',
SA_Points_Group(1) =
'$EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin.copy',
SA_Emiss_Group_Grid(1,1) = '$EMIS2/camx.ar.bart.36km.$JDATE.bin.copy',
PSAT_Treat_SULFATE_Class = .true.,
PSAT_Treat_NITRATE_Class = .true.,
PSAT_Treat_SOA_Class = .false.,
PSAT_Treat_PRIMARY_Class = .true.,
PSAT_Treat_MERCURY_Class = .false.,
PSAT_Treat_OZONE_Class = .false.,
```

&

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```
#  
# --- Execute the model ---  
#  
  
echo '---- Running for Date '$JDATE  
  
cp CAMx.in $run/camx.$RUN.$run.$JDATE.in  
/usr/bin/time $EXEC >& $run/camx.$RUN.$run.$JDATE.stdout  
  
rm -fv $EMIS/final.${YYYY}${MM}${DD}.RPO_US36.Base02f.pt.revised.bin.copy  
>> & $OUTPUT/camx.$RUN.$JDATE.stdout  
rm -fv $EMIS2/camx.ar.bart.36km.$JDATE.bin.copy >> &  
$OUTPUT/camx.$RUN.$JDATE.stdout  
  
@ JDATE++  
if( $JDATE == 2001366 ) set JDATE = 2002001  
  
end
```